



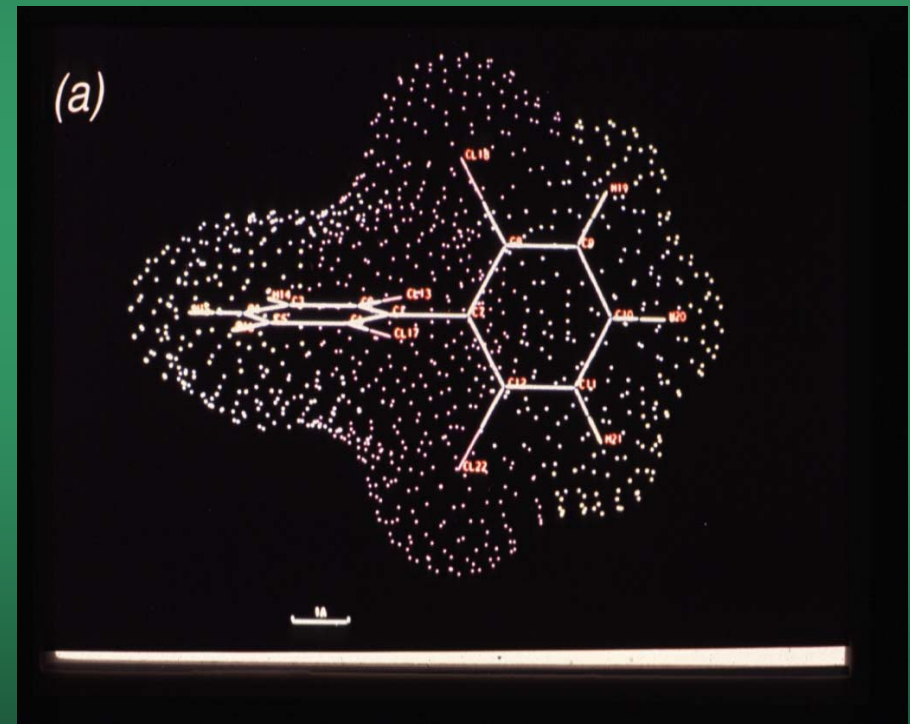
# Stage 1 TMDLs for PCBs for the Delaware Estuary

September 2003



# PCBs


- ❑ Man-made organic chemicals with a biphenyl base structure and 209 possible chlorine substitution patterns.
- ❑ Terminology: Aroclors, congeners, homologs.
- ❑ Properties: Hydrophobic, tend to accumulate in sediments and tissues.

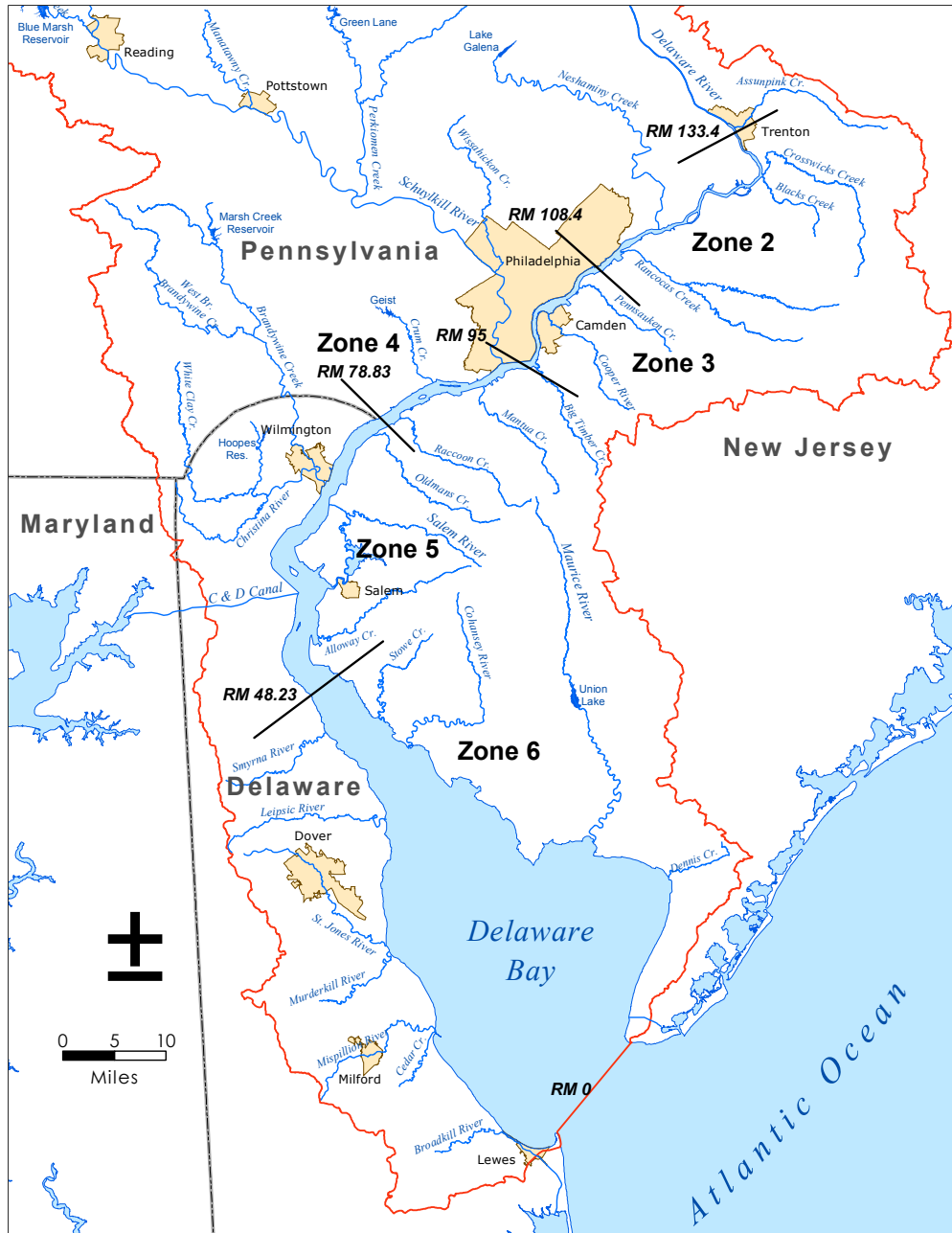


# Effects of PCBs

- ☐ Probable Human Carcinogen
- ☐ Developmental Effects
- ☐ Neurobehavioral Effects
- ☐ Reproductive Effects
- ☐ Immunosuppressant

# History

- ❑ Clean Water Act of 1987.
- ❑ Estuary Toxics Management Program authorized in 1987 to address toxic pollutants in Zones 2 to 5. 
- ❑ Toxics Advisory Committee established in 1994.
- ❑ Water quality criteria for toxic pollutants for Zones 2 – 5 adopted in 1996.
- ❑ 1998 – All three states list the estuary as impaired requiring the development of TMDLs.



# Zone Designations for the Delaware Estuary



# History (cont.)

- ❑ Spring 2000 – DRBC designated the lead agency to develop the TMDLs for PCBs by the end of 2003.
- ❑ Expert Panel established – Sept. 2000.
- ❑ PCB Strategy developed by subcommittee of TAC – March 2001.
- ❑ Staged approach to establishing TMDLs – first discussed in Spring 2002.
- ❑ Modeling Consultant (Limno-Tech, Inc.) – Spring 2002

# History (cont.)

## □ Modeling Objectives

### ① Gain understanding:

- ✓ Determine PCB load-response relationships.
- ✓ Determine principal controlling processes.

### ② Address management questions:

- ✓ Determine PCB TMDL for each zone.
- ✓ Allocate TMDLs among sources.
- ✓ Assess the impact of load reduction strategies.

# PCB Strategy Elements

- ❑ The strategy consists of nine elements:
  - ➊ Determine the water quality targets for the TMDLs.
  - ➋ Characterize PCB concentrations in the estuary ecosystem.
  - ➌ Identify and quantify sources and pathways of PCBs to the estuary.
  - ➍ Determine the transport and fate of PCBs loads within the estuary.
  - ➎ Establish TMDLs and allocations for sources to achieve water quality standards.



# PCB Strategy Elements (cont.)

- ⑥ Develop an implementation plan to reduce PCBs entering the estuary.
- ⑦ Increase environmental awareness of toxicity issues within the estuary.
- ⑧ Monitor long-term concentrations of PCBs in the air, water and sediments of the estuary.
- ⑨ Monitor long-term concentrations and impacts to living resources of the estuary.

# Stakeholder Participation

- ❑ The Commission's Toxic Advisory Committee forms the core of the stakeholder involvement in the PCB TMDL Process.
  - ✓ 13 members
  - ✓ Includes representatives from governmental agencies, regulated community, academia, environmental/watershed, agriculture, public health and fish & wildlife resource.
  - ✓ Provides formal recommendations to the Commission.

# Stakeholder Participation

- ❑ Several coalitions of NPDES dischargers were also formed. One provided technical support in the development of the water quality model.
  - HydroQual, Inc. performed a decadal scale (74 year) consistency check of the model parameters that were determined during a 19 month short-term calibration period.
- ❑ A suite of public outreach meetings were held in the spring of 2001 to discuss the planned TMDL development process.

# Stakeholder Participation

- ❑ Science Symposium – October 2002
  - Sponsored by Delaware Estuary TMDL Coalition.
  - Objectives:
    - ✓ Summarize key findings from scientific studies.
    - ✓ Discuss how data/findings can be used in the model.
    - ✓ Identify additional data needs.
  - Focused on science and data, not on policy
- ❑ An Implementation Advisory Committee is planned to assist in PCB minimization efforts.

# Data Collection Efforts

- ❑ Under the guidance of the Expert Panel, a number of scientific investigations and data collection efforts were initiated including:
  - ✓ Sedimentological surveys.
  - ✓ Air deposition monitoring in PA and DE to complement the NJADN.
  - ✓ Surficial sediment survey.
  - ✓ Tributary monitoring.
  - ✓ Bioaccumulation studies.
  - ✓ Low level, congener-specific analyses of ambient water samples.

# Delaware River PCB Model (DELPCB)



- ❑ Modified version of DYNHYD5/TOXI5
- ❑ EPA-supported and widely used for toxic chemical TMDLs and contaminated sediments.
- ❑ Model formulations/code extensively tested and assessed with observations at numerous sites.
- ❑ Builds upon modeling work at other sites:
  - ✓ Kalamazoo River RI/FS
  - ✓ New York Harbor CARP Model
  - ✓ Green Bay Mass Balance Study
  - ✓ Upper Hudson River RI/FS
  - ✓ Fox River RI/FS

# Delaware River PCB Model (DELPCB)



- ☐ Represents water column and sediments
- ☐ One-dimensional in longitudinal
  - ✓ 87 spatial segments
- ☐ Time-variable
- ☐ Hydrodynamics
  - ✓ Tidal heights
  - ✓ Chloride mass balance
- ☐ Organic carbon sorbent dynamics
  - ✓ Particulate carbon (biotic and detrital)
  - ✓ Dissolved organic carbon
- ☐ Penta PCB homolog

## Zone 2

### Zone 3

### Zone 4

## Zone 5

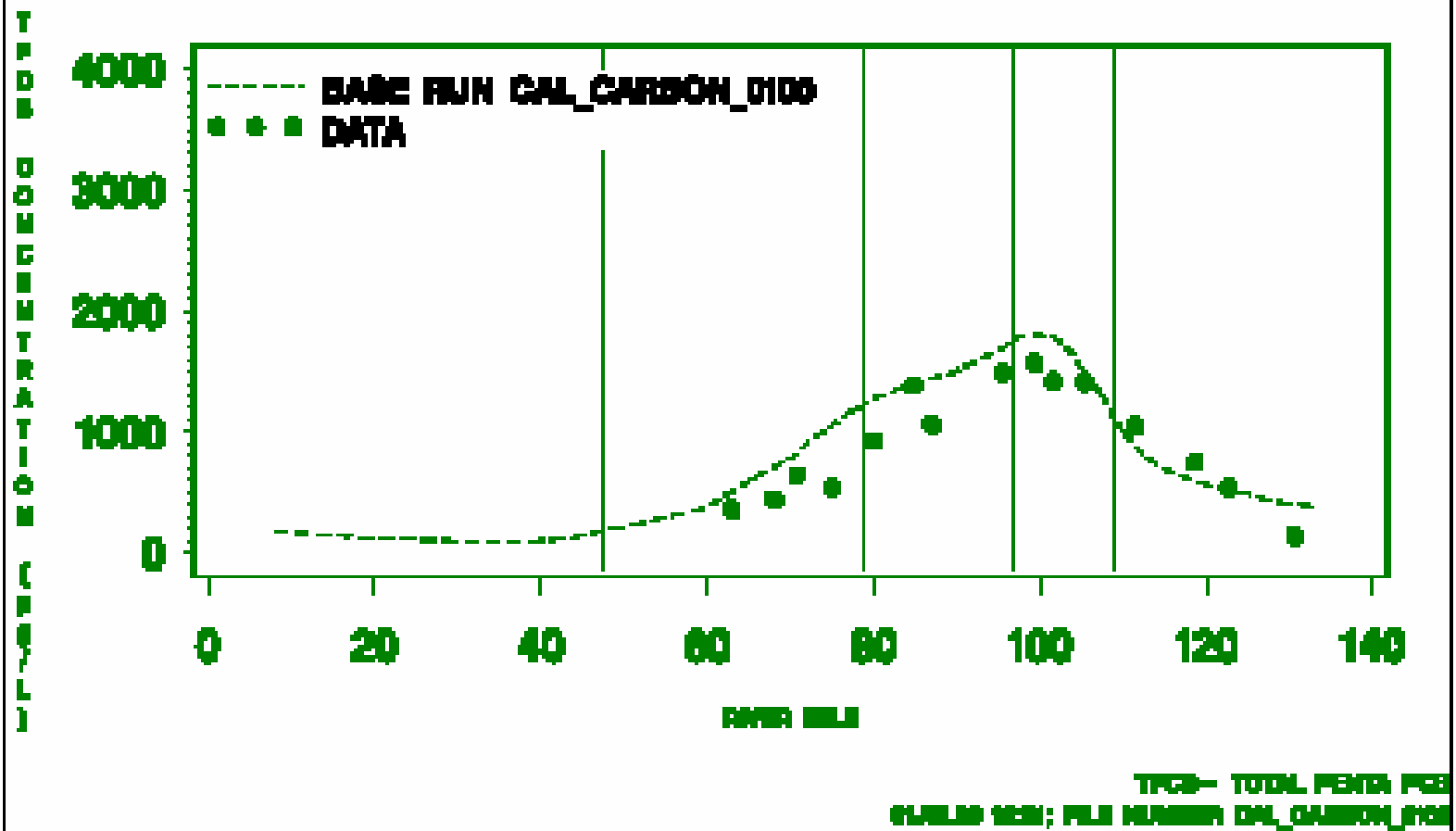
### Zone 6



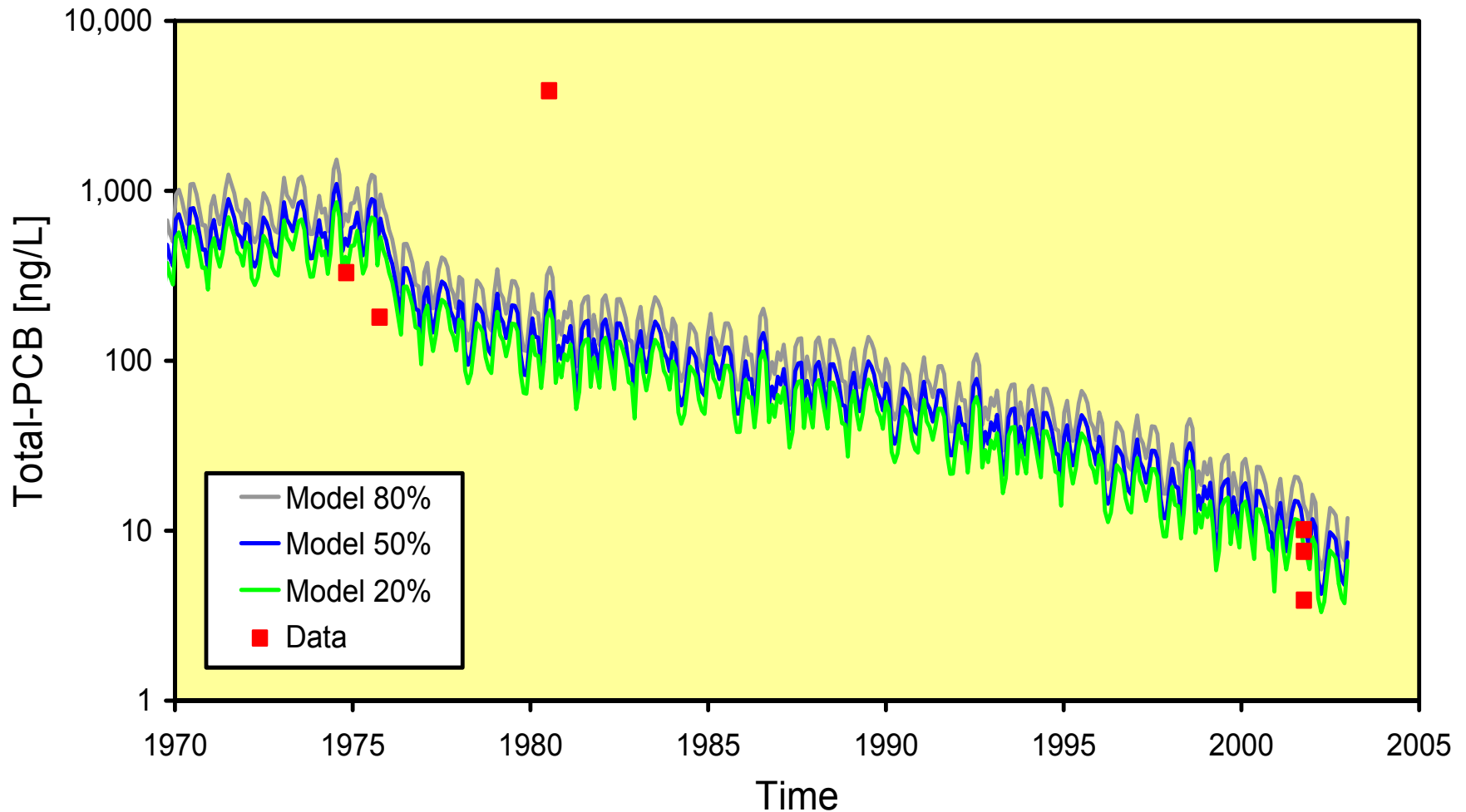


# Short-term Calibration for penta-CB

CALIBRATION RUN ON TPCH - WIC TPCH ON 10-08-02

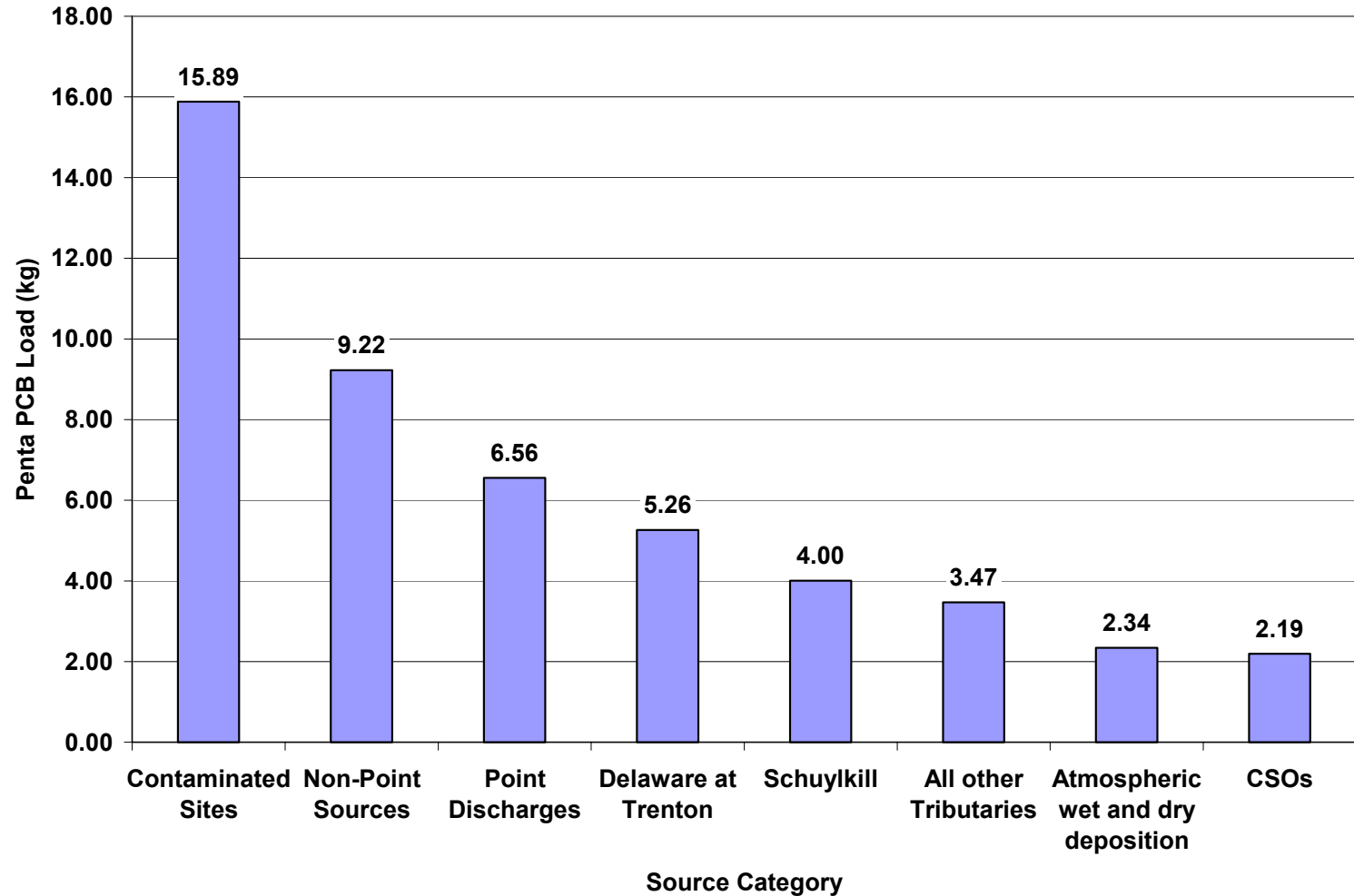


# Decadal Scale Calibration for penta-PCB



# Penta-PCB Load by Source Category

## September 1, 2001 through March 31, 2003



# Key Findings



- ❑ The principal sources of PCB loadings are contaminated sites, non-point sources and point sources.
- ❑ Atmospheric gas phase absorption is a significant PCB source in the middle estuary.
- ❑ PCB loadings at head of tide (Trenton) have a significant influence in the tidal Delaware River.
- ❑ Water column PCBs are more strongly influenced by loadings than by sediments.

# Summary points

- ❑ Model for PCBs is developed and calibrated.
- ❑ Model is scientifically credible.
- ❑ Collaboration with Delaware Estuary TMDL Coalition
  - ❑ Avoided adversarial process and a competing model
- ❑ Model being used to develop Stage 1 PCB TMDL, but Stage 2 is necessary to address uncertainties.
- ❑ Model can be extended to other contaminants and to other watersheds.

# Establishing TMDLs

- ❑ TMDLs are estimates of the loadings of each of the PCB homologs that can enter the estuary and still meet the current water quality criteria. They are *projected loadings* from all sources based upon assumptions called design conditions.
- ❑ Since current concentrations of PCB homologs are 500 times higher than the water quality criteria, the TMDLs and associated individual WLAs and LAs will be proportionately less.

# Background

- ❑ Consistent with the resolution passed by the Commission in March 2003 regarding the new proposed criteria for Zones 2-5, and the letter from EPA Regions II and III dated April 16, 2003, the existing DRBC human health criteria will be the basis for the TMDLs.

|                           | Zones 2 & 3 | Zone 4 &<br>Upper Zone 5 | Rest of<br>Zone 5 |
|---------------------------|-------------|--------------------------|-------------------|
| Existing DRBC<br>Criteria | 44.4 pg/l   | 44.8 pg/l                | 7.9 pg/l          |

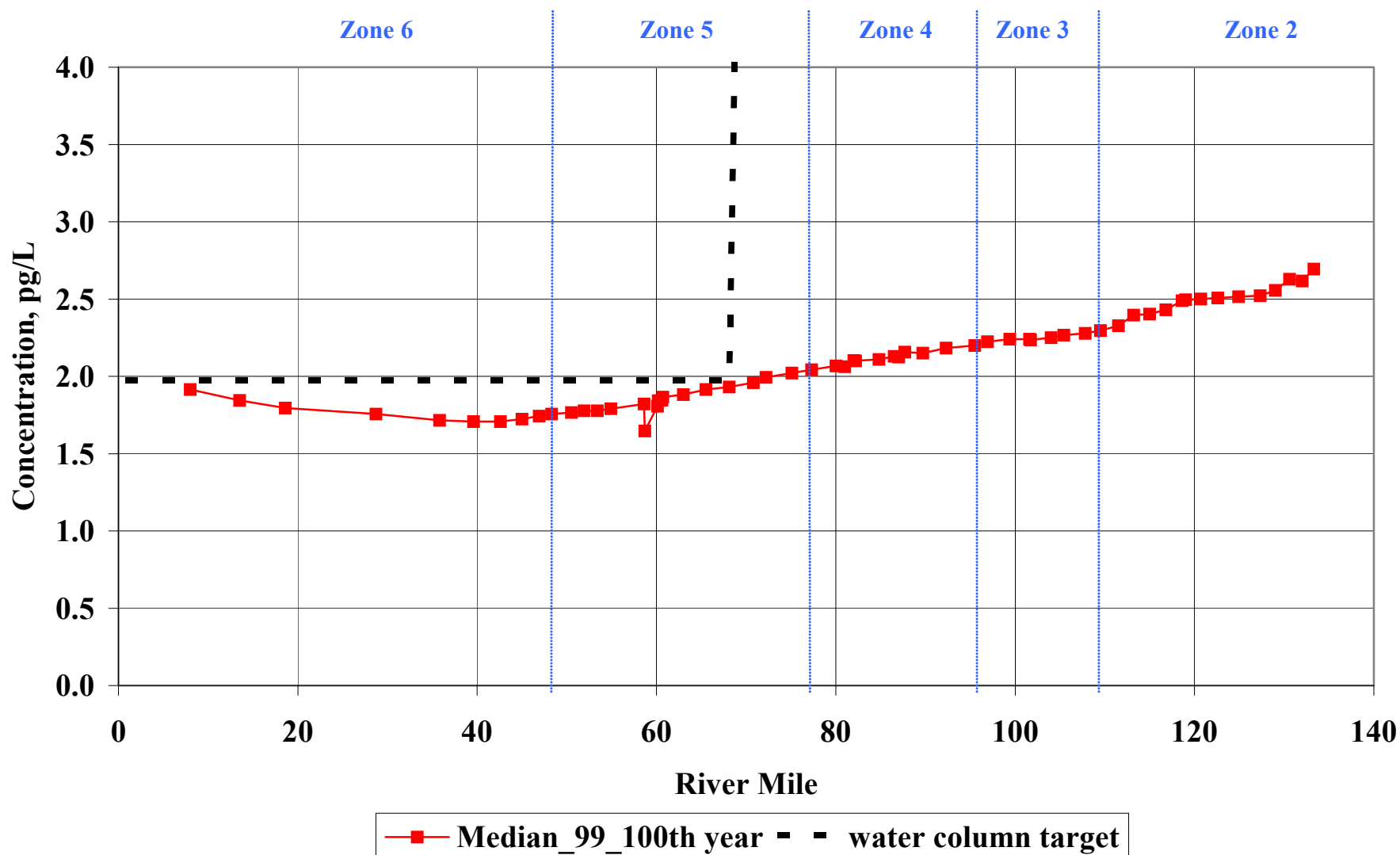
# Background

- Since the current model is for pentachlorobiphenyls (5 chlorine homolog group), an equivalent penta-PCB water quality target must be used to determine the TMDLs.

|                             | Zones 2 & 3 | Zone 4 &<br>Upper Zone 5 | Rest of<br>Zone 5 |
|-----------------------------|-------------|--------------------------|-------------------|
| Equivalent Penta-PCB Target | 11.1 pg/l   | 11.2 pg/l                | 1.975 pg/l        |



# Penta-PCB Water Column Concentrations at TMDL Loads, 100 year simulation



# Summary of Approach for Stage 1



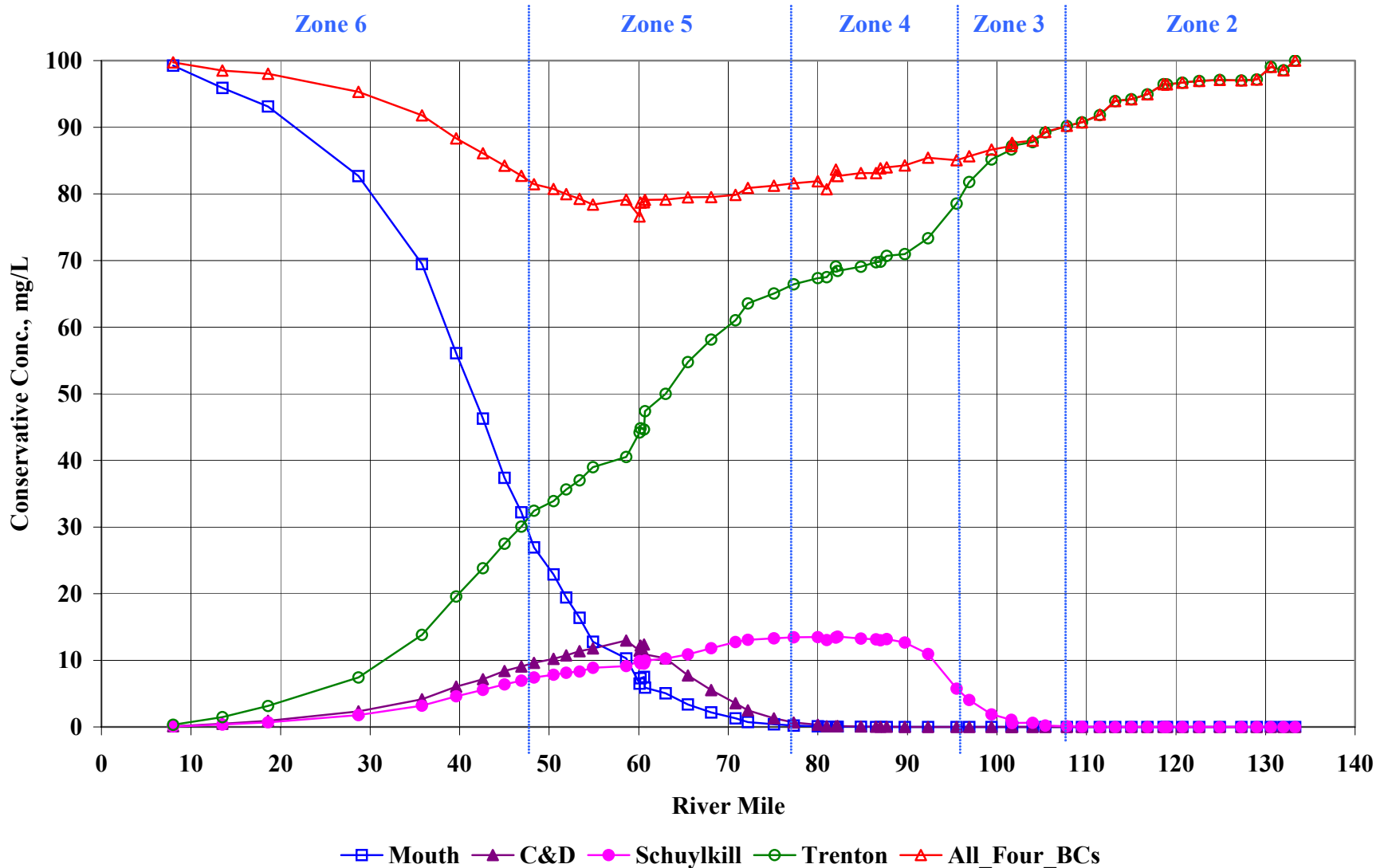
- ❑ Utilize both a conservative chemical (chloride) and the penta-PCB models that cycle inputs from the period February 1, 2002 to January 31, 2003.
- ❑ Calculate annual median TMDL loadings to be consistent with both the model simulations and the 70 year exposure for human health criteria.

# Summary of Approach for Stage 1

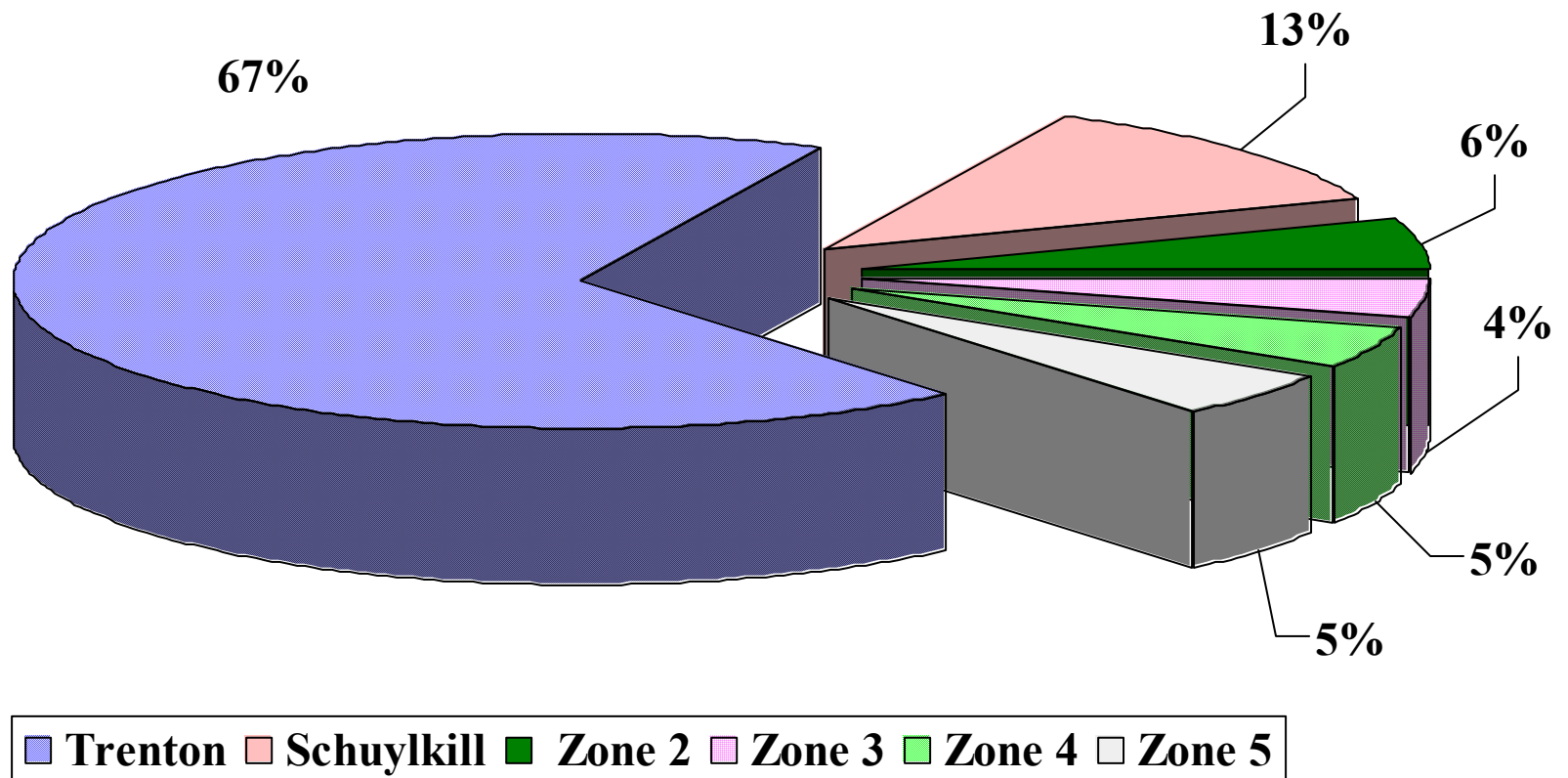
- TMDLs are calculated in a 4 step procedure:
  - ① Calculate the contribution factor for each of the estuary zones and two of the model boundaries to the critical location (RM 68.75). ▶
  - ② Calculate the allowable loadings from each of these six sources that will meet the water quality target (1.975 pg/l). Include the assimilative capacity provided by net burial of PCBs to the sediments.

# Spatial Plot: Relative Impact of the Boundary Conditions:

Median Values: BC = 100mg/l for Mouth of the Bay, C&D, Schuylkill, and/or Trenton



# Flow Distribution in Delaware Estuary




# Summary of Approach for Stage 1

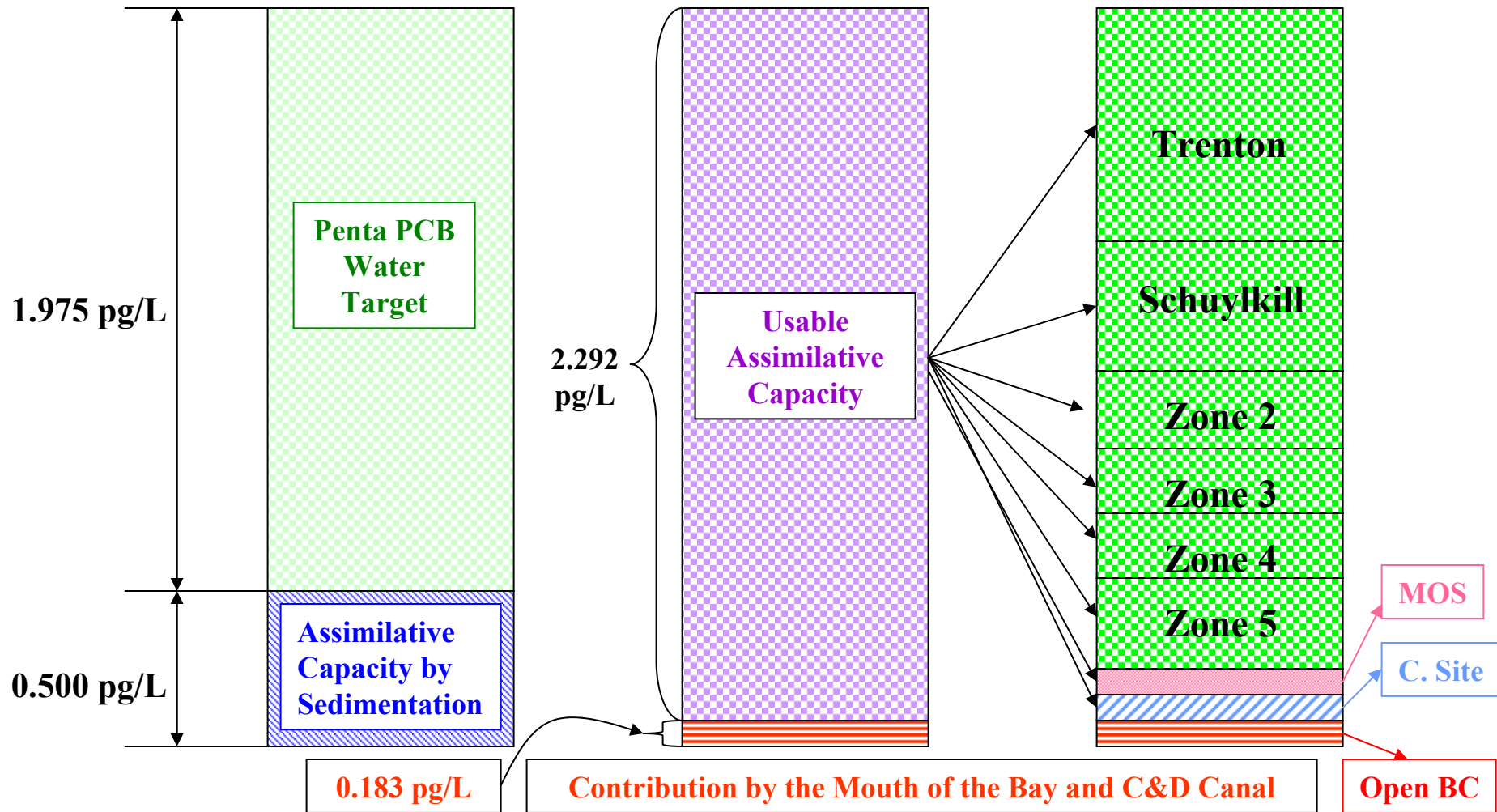


- ⑤ Utilize the penta-PCB model to confirm that sediment concentrations have reached steady-state, and that the water quality target is met.
- ⑥ Include the exchange of gas phase PCBs in the air with dissolved PCBs in the water, and utilize the penta-PCB model to confirm that the water quality target is met.

# Summary of Approach for Stage 1

- ❑ Allocate 5% of each of the zone TMDLs to a margin of safety (MOS).
- ❑ Allocate to the contaminated sites category. 
- ❑ Allocate the remainder of the zone TMDLs to a WLA portion and a LA portion based upon the current percentage contribution for each of the source categories to each zone during the period February 1, 2002 to January 31, 2003.

# Allocation of the Assimilative Capacity at the Critical Location

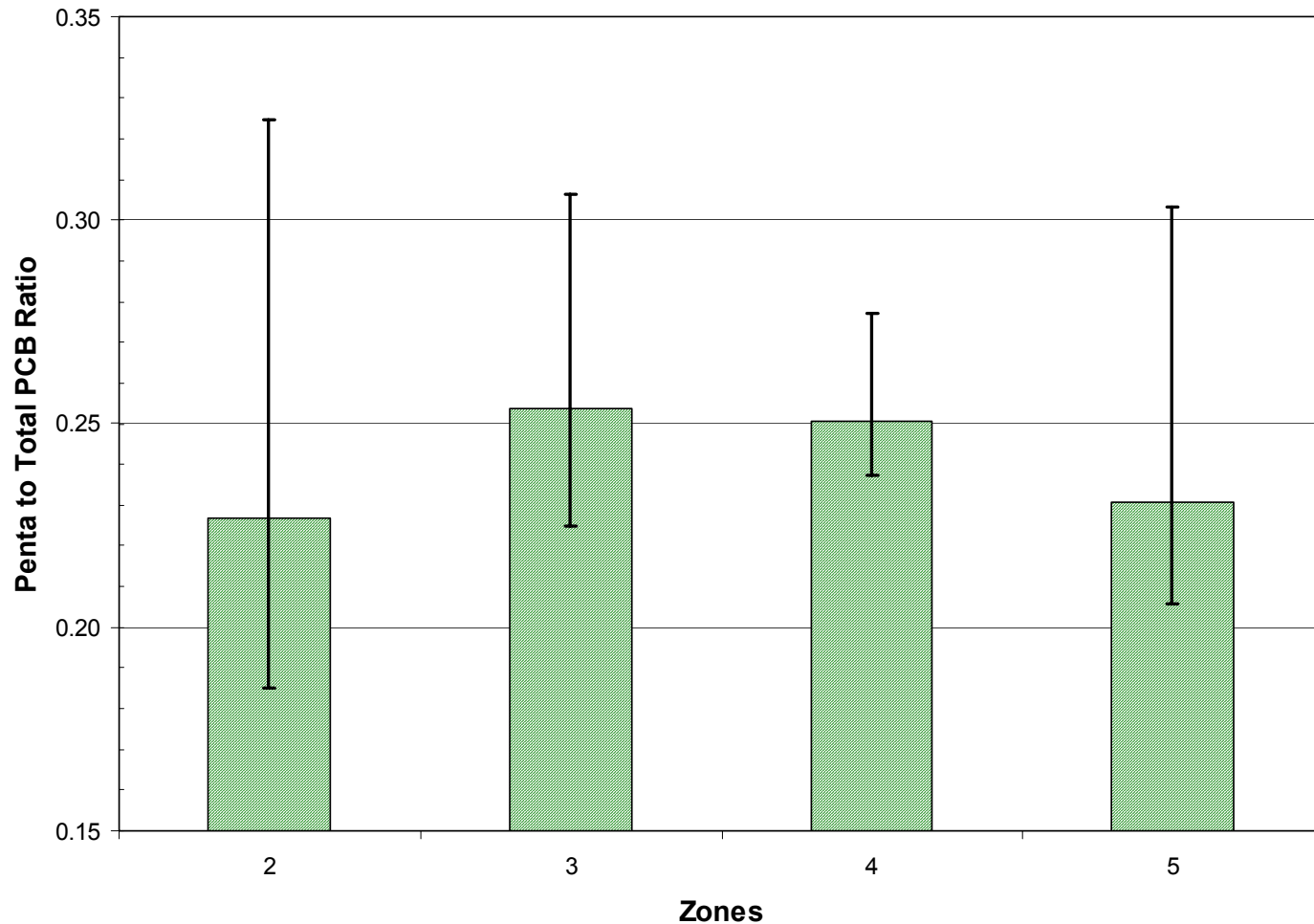




# Summary of Approach for Stage 1

- ❑ Using the estuary-wide ratio of penta-PCBs to Total PCBs from ambient data collected in the Delaware Estuary, the zone-specific, penta-PCB TMDLs will be scaled up using a fixed ratio of 1:4 to calculate the TMDL.

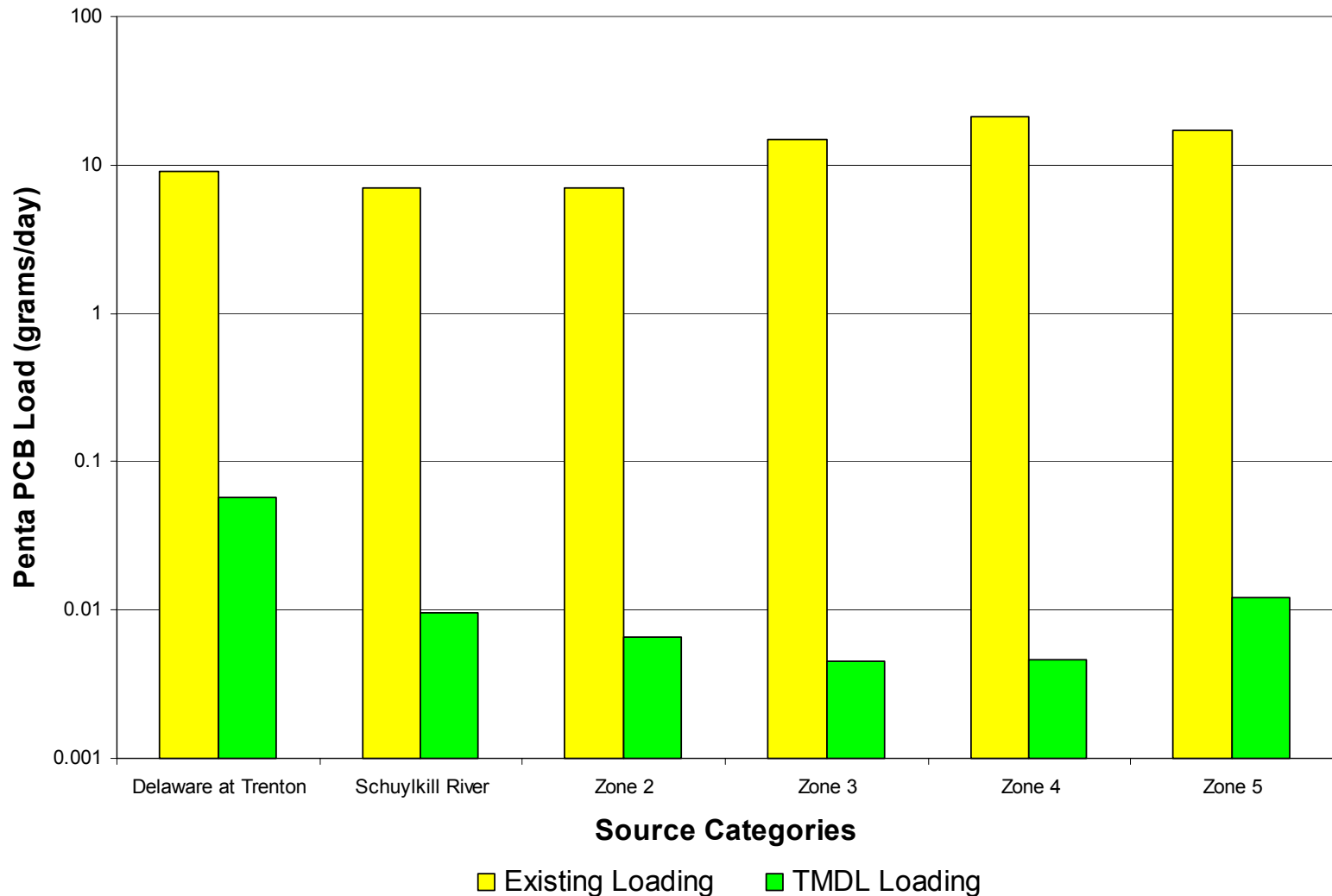
# Ratio of Penta-PCBs to Total PCBs in Ambient Samples



# Stage 1 TMDLs for Total PCBs

| Estuary Zone | TMDL   | WLA    | LA     | MOS    |
|--------------|--------|--------|--------|--------|
|              | mg/day | mg/day | mg/day | mg/day |
| Zone 2       | 257.4  | 5.0    | 239.5  | 12.9   |
| Zone 3       | 17.8   | 4.9    | 12.0   | 0.9    |
| Zone 4       | 56.7   | 5.2    | 48.7   | 2.8    |
| Zone 5       | 48.1   | 13.3   | 32.4   | 2.4    |
| Sum          | 380.0  | 28.3   | 332.6  | 19.0   |

# Comparison of Current Penta-PCB Loads to TMDLs



# Allocation of Zone TMDLs

□ The current percentage contribution for:

✓ Wasteload Allocations

✓ Load Allocations

for each zone based upon the respective loadings during the period Feb. 1, 2002 to Jan. 31, 2003, and the designated margin of safety.

| Zone | WLA   | LA    |
|------|-------|-------|
| 2    | 8.4%  | 91.6% |
| 3    | 29.1% | 70.9% |
| 4    | 17.6% | 82.4% |
| 5    | 29.0% | 71.0% |

# Approach for Establishing Stage 2 TMDLs

- ❑ The approach for establishing Stage 2 TMDLs is expected to be different than that used in Stage 1.
- ❑ Some of the reasons for this are:
  - ❶ The proposed human health criteria for total PCBs does not produce a sharp transition between zones.
  - ❷ An alternative allocation procedure for both the aggregate WLAs and LAs, and the individual WLAs and LAs that is more equitable will be needed.

# Approach for Establishing Stage 2 TMDLs



- ③ TMDLs for total PCBs for each zone will be the sum of the TMDLs for each homolog without extrapolation.
- ④ Alternative source reduction strategies that result from either the PCB Minimization Plans required in Stage 1 or the efforts of the PCB Implementation Committee will need to be implemented in the apportioning of the zone TMDLs, where appropriate.

# Summary



- ❑ Four documents have been prepared for use by the U.S. EPA in establishing the TMDLs:
  - ① Stage 1 TMDL Support Document.
  - ② Hydrodynamic Model for the Delaware Estuary.
  - ③ Water Quality Model for penta-PCBs for the Delaware Estuary.
  - ④ Calibration of the Water Quality Model for penta-PCBs.
- ❑ These documents are available on the DRBC website: [www.drbc.net](http://www.drbc.net)



# Summary (cont.)



- ❑ A public hearing is scheduled for Thursday October 16, 2003 at Independence Visitor Center, One North Independence Mall West in Philadelphia, PA from 7:00 to 9:00 PM.
- ❑ The public comment period closes at on Tuesday October 21, 2000. Comments shall be submitted to Lenka Berlin, Office of Watersheds (3WP10), U.S. EPA, 1650 Arch St., Philadelphia, PA 19103-2029. Email address: [berlin.lenka@epamail.epa.gov](mailto:berlin.lenka@epamail.epa.gov).